

NATURAL RESOURCES CONSERVATION SERVICE CONSERVATION PRACTICE STANDARD

DIKE (Feet) CODE 356

DEFINITION

An embankment constructed of earth or other suitable materials to protect land against overflow or to regulate water.

SCOPE

This standard applies to dikes or levees used to prevent or reduce flood damage to land and property, for flow control in conjunction with floodways, or to impound or regulate water for fish and wildlife management.

Dikes are divided into classes determined by the value of the land, crops, and other improvements and the hazard to life within the area to be protected.

PURPOSE

To permit improvement of agricultural land by preventing overflow and better use of drainage facilities, to prevent damage to land and property, and to facilitate water storage and control in connection with wildlife and other developments. Dikes can also be used to protect natural areas, scenic features, and archeological sites from damage.

CONDITIONS WHERE PRACTICE APPLIES

Class I dikes are those constructed on sites where:

1. Failure may cause loss of life or serious damage to homes, industrial and commercial buildings, important public utilities, main highways or railroads, and high value land, crops, or other improvements.

2. Unusual or complex site conditions require special construction procedures to ensure satisfactory installations.
3. Protection is needed to withstand more than 12-feet (3.7 m) of water above normal ground surface, exclusive of crossings of sloughs, old channels, or low areas.

Class II dikes are those constructed in highly developed and productive agricultural areas where:

1. Failure may damage isolated homes, highways or minor railroads, or cause interruption in service of relatively important public utilities.
2. The maximum design water stage against the dike is 12-feet. (3.7 m).

Class III dikes are those constructed in rural or agricultural areas where:

1. Damage likely to occur from dike failure is minimal.
2. The maximum design water stage against the dike is 6-feet (1.8 m) for mineral soils and 4-feet (1.2 m) for organic soils. (Exclude channels, sloughs, swales, and gullies in determining the design water stage.)

Dike construction usually constitutes an encroachment on the flood plain requiring a state permit.

DESIGN CRITERIA - ALL DIKES

In locating dikes, careful considerations shall be given to preserving natural areas, fish and

wildlife habitat, woodland, and other environmental resources. If dike construction will adversely affect such values, concerned public agencies and private organizations shall be consulted about the project.

Protection. A protective cover of grasses shall be established on all exposed surfaces of the dike and other disturbed areas. Seedbed preparation, seeding, fertilizing, mulching, and fencing shall comply with recommendations in local technical guides.

If vegetation will not control erosion, riprap or other protective measures shall be installed.

Maintenance. All dikes must be adequately maintained to the required shape and height. The maintenance of dikes must include periodic removal of woody vegetation that may become established on the embankment. Provisions for maintenance access must be provided. The dike shall be fenced where necessary to control grazing and provide protection for the vegetation.

DESIGN CRITERIA - CLASS I DIKES

Location. Conditions to be considered in designing Class I dikes are foundation soils, property lines, exposure to open water, adequate outlets for gravity or pump drainage, and access for construction and maintenance. Mineral soils that will be stable in the dike embankment must be available.

Height. The design height of a dike shall be the design high water depth plus 2-feet (0.6 m) of freeboard or 1-foot (0.3 m) of freeboard plus an allowance for wave height, whichever is greater. Design elevation of high water shall be determined as follows:

1. If dike failure is likely to cause loss of life or extensive high-value crop or property damage, the elevation of design high water shall be that associated with the stage of the 100 year frequency flood or of the maximum flood of record, whichever is greater.

2. If dike failure is unlikely to result in loss of life or extensive high-value crop or property damage, the elevation of design high water shall be that associated with the peak flow from the storm that will ensure the desired level of protection or the 50 year frequency flood, whichever is greater.
3. If the dike will be subject to stages from more than one stream or source, the criteria indicated should be met for the combination that causes the highest stage.

The design height of the dike shall be increased by the amount needed to ensure that the design top elevation is maintained after settlement. This increase shall be not less than five percent.

Interior drainage. If inflow from the area to be protected by the dike may result in loss of life or extensive high-value crop or property damage, provisions shall be included in the plans to provide interior protection against a 100 year frequency hydrograph, plus base flow, and an allowance for seepage, and may include storage areas, gravity outlets, or pumping plants, alone or in combination.

If inflow from the area to be protected by the dike is unlikely to result in loss of life or extensive high-value crop or property damage, storage areas, gravity outlets, or a pumping plant, alone or in combination, shall be included in the plans and designed to handle the discharge from the drainage area based on drainage requirements established for the local area or the peak flow from the storm that will insure the desired level of protection, whichever is greater.

In sizing outlet works in combination with available storage, the minimum design storm duration for interior drainage shall be ten days. If outlet works are designed using peak flood frequency flows without considering storage, the minimum design storm duration shall be 24 hours.

Embankment and foundation. The embankment shall be constructed of mineral soils, which when placed and compacted will result in a stable earth fill. No organic soil shall be used in the dike. Soils must have high specific gravity and be capable of being formed into an embankment of low permeability. The design of the embankment and specifications for its construction shall give due consideration to the soil materials available, foundation conditions, and requirements for resisting the action of water on the face of the dike and excessive seepage through the embankment and the foundation. The design of the embankment and the foundation requirements shall be based on the length of time and height that water will stand against the dike.

Minimum requirements for certain features of the embankment, the foundation, and borrow pits are as follows:

Minimum top width of Class T dikes shall be 10-feet (3 m) for embankment heights of 15-feet (4.6 m) or less and 12-feet (3.7 m) for heights more than 15-feet (4.6 m). If maintenance roads are to be established on the dike top, "turnarounds" or passing areas shall be provided, as needed.

Side slopes shall be determined from a stability analysis, except that an unprotected earth slope on the waterside shall not be steeper than 4 horizontal to 1 vertical if severe wave action is anticipated.

If dikes cross old channels or have excessively porous fills or poor foundation conditions, the landside toe shall be protected by a banquette or constructed berm. Banquettes shall be used to provide construction access and added stability if channel crossings are under water or saturated during construction. Banquettes shall be designed on the basis of site investigations, laboratory analysis, and compaction methods. The finished top width of the banquettes shall not be less than the height of dike above mean ground. The finished top of the banquettes shall be not

less than 1-foot (0.3 m) above mean ground and shall be sloped away from the dike.

A cutoff shall be used if foundation materials are sufficiently pervious to be subject to piping or undermining. The cutoff shall have bottom width and side slopes adequate to accommodate the equipment to be used for excavation, backfill, and compaction operations. It shall be backfilled with suitable material placed and compacted as required for the earth embankment. If pervious foundations are too deep to be penetrated by a foundation cutoff, a drainage system adequate to ensure stability of the dike shall be used.

Ditches and borrow pits. Landside ditches or borrow pits shall be located so the hazard of failure is not increased. Ditches for borrow pits when excavated on the water side of dikes shall be wide and shallow. Plugs, at least 15-feet (4.6 m) in width, shall be left in the ditches at intervals not greater than 400-feet (121.9 m) to form a series of unconnected basins.

Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be:

Fill height	Minimum berm width
Less than 6-feet (1.8 m)	12-feet (3.7 m)
More than 6-feet (1.8 m)	18 feet (5.5 m)

A drainage system shall be used if necessary to ensure the safety of a dike. Toe drains, if used, shall be located on the landside and shall have a graded sand-gravel filter designed to prevent movement of the foundation material into the drain.

Subsurface drains shall not be installed, or permitted to remain without protection, closer to the landside toe of a dike than a distance three times the design water height for the dike. If subsurface drains are to be installed or remain closer than the distance stated, protection shall consist of a graded

sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

Pipes and conduits. Dikes shall be protected from scour at pump intakes and discharge locations by appropriate structural measures. A pump discharge pipe through a dike shall be installed above design high water, if feasible, or be equipped with anti-seep collars.

All conduits through a dike below the design high waterline shall be equipped with anti-seep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed water line shall be equipped with a Dayton or a similar coupling to prevent vibration of the pumping plant being transmitted to the discharge conduits.

DESIGN CRITERIA--CLASS II DIKES

Design water stage. The maximum design water stage permitted is 12-feet (3.7 m) above normal ground level exclusive of crossings at channels, sloughs, and gullies.

If the design water depth against dikes, based on the required level of protection, exceeds 4-feet (1~2 m) the design shall be based on at least a 25 year frequency flood. If this degree of protection is not feasible, the design shall approach the 25-year flood level as nearly as possible, and planned fuse plug sections and other relief measures. shall be installed where appropriate.

Height. The design height of an earth dike shall be the design water depth plus a freeboard of at least 2-feet (0.6 m) or freeboard of 1-foot (0.1 m) plus an allowance for wave height, whichever is greater.

The constructed height of the dike shall be the design height plus an allowance for settlement necessary to ensure that the design top elevation is maintained but shall be no less than five percent of the design height.

Interior drainage. Provisions must be made for adequate drainage for the area to be protected by the dike.

Cross section. The minimum requirements for the cross section of the dike where fill is compacted by hauling or special equipment shall be as follows:

Design water height		Minimum top width		Steepest side Slope
ft	m	ft	m	
0-6	(0-1.8)	6	(1.8)	2 ½:1
6-12	(1.8-3.7)	8	(2.4)	2 ½:1

If soils or water conditions make it impractical to compact the dike with hauling or special equipment, dumped fill may be used and shall have minimum cross section dimensions incorporated in the fill as follows:

Design water height		Minimum top width		Steepest side Slope
ft	m	ft	m	
0-6	(0-1.8)	8	(2.4)	2:1
6-12	(1.8-3.7)	10	(3)	2- ½:1

Side slopes of 3 horizontal to 1 vertical on waterside and 2:1 on landside may be used instead of 2-1/2:1 for both slopes.

The cross sections shall be strengthened or increased as required to provide additional protection against floods of long duration. The top width shall be not less than 10-feet (3 m) if a maintenance road is planned on top of the dike. "Turnarounds" or passing areas shall be provided as required on long dikes.

The side slopes shall be 3:1 or flatter on the waterside if severe wave action is expected or if a steeper slope would be unstable under rapid drawdown conditions. Side slopes shall be 3:1 or flatter on both sides where permeable soils of low plasticity, such as SM and ML, are used in construction.

A banquette (or constructed berm) shall reinforce the landside toe if a dike crosses an old channel or if excessively porous fill or poor

foundation conditions justify such reinforcement. Such banquettes shall be used if, during construction, the channel crossing is under water or saturated. The top width of the banquette shall be equal to or greater than the fill height of the dike above the top of the banquette unless a detailed investigation and analyses show a different design is adequate.

Foundation cutoff. A cutoff shall be installed if there are layers of permeable soils or layers creating a piping hazard through the foundation at a depth less than the design water depth of the dike below natural ground level. The cutoff trench shall be of sufficient depth and width and filled with suitable soils to minimize such hazard.

Ditches and borrow pits. Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be:

Fill height	Minimum berm width
Less than 6-feet (1.8 m)	10-feet (3 m)
More than 6-feet (1.8 m)	15 feet (4.6 m)

A landside ditch or borrow pit shall be far enough away from the dike to minimize any hazard to the dike because of piping through the foundation.

For dikes having a design water depth of more than 5-feet (1.5 m), the landside ditch or borrow pit shall be far enough away from the dike so that a line drawn between the point of intersection of the design waterline with the waterside of the dike and the landside toe of a dike meeting minimum dimensional requirements shall not intersect the ditch or borrow pit cross section.

Pipes and conduits. The dike shall be protected from scour at a pump intake and discharge by appropriate structural measures. A pump discharge pipe through the dike shall be installed above design high water, if feasible, or else equipped with anti-seep collars.

All conduits through the dike below the design high waterline shall be equipped with anti-seep collars designed to increase the distance of the seepage line along the conduit by at least 15 percent. Discharge conduits of pumps placed below the designed waterline shall be equipped with a Dayton or a similar coupling to prevent vibrations of the pumping plant being transmitted to the discharge conduits.

Drains. Drains shall be used where necessary to ensure safety of dikes and shall be located on the landside, have a graded sand-gravel filter, and be designed and installed in accordance with Natural Resources Conservation Service standards for such drains.

Field subsurface drains shall not be installed or permitted to remain without protection closer to the landside toe of a dike than a distance three times the design water height for the dike. If such drains are to be installed or remain closer than the distance stated above, protection shall consist of a graded sand-gravel filter, as for a toe drain, or a closed pipe laid within the specified distances from the dike.

DESIGN CRITERIA--CLASS III DIKES

The design criteria shall be based on site conditions for mineral or organic soils as applicable.

Top width. Minimum top width is 6-feet (1.8 m).

Side slopes. Minimum side slope is 2:1.

Freeboard. The minimum freeboard is 1-foot (0.3 m) plus wave height. The constructed height shall be increased by the amount necessary to insure that the settled top is at design elevation but not less than five percent.

Foundation cutoff. A cutoff shall be installed if necessary to ensure dike stability.

DITCHES AND BORROW PITS

Minimum berm widths between the toe of the dike and the edge of the excavated channel or borrow shall be two times the depth of the ditch but not less than 8-feet (2.4 m).

PLANS AND SPECIFICATIONS

Plans and specifications for constructing dikes shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

DIKE SPECIFICATIONS

All Dikes. All materials used in structural measures shall conform to materials specifications found in Pond (378).

Preparation of sites for dike construction shall be done in a manner, which destroys as little vegetation outside the areas to be occupied by dikes and borrow pits as feasible. Special efforts shall be made to save trees of significant value, which are not in the area to be occupied by the dike.

Construction operations shall be carried out in a manner to minimize air and water pollution and hold such pollution within legal limits. Bare areas shall be revegetated as soon as practical after earthwork is completed. A minimum area should be stripped of vegetation at any one time to provide an adequate work site.

Disposal of debris from site preparation shall be done in a manner to cause minimum pollution to the environment.

Class I and II Dikes

Foundation Preparation. The foundation area shall be cleared of all trees, stumps, roots, brush, boulders, sod, and debris. All channel banks and sharp breaks shall be sloped no steeper than 1:1. Soil, which is high in organic matter, shall be removed. The surface of the foundation area shall be thoroughly scarified before placement of the embankment material.

The cutoff trench, where used, shall be excavated to lines and grades as shown on the plans. It shall be backfilled with suitable material in a manner as specified for earth embankment. The necessary degree of compaction shall be obtained by using equipment adapted to site conditions. The trench shall be kept free of standing water during backfill operations. The material from the cutoff trench may be placed within the dike section if suitable.

Conduit Installation. All conduits through a dike shall be placed on a firm foundation to the lines and grades shown on the plans. Selected backfill material shall be placed in layers around the conduits and their component parts and each successive layer shall be thoroughly compacted.

Embankment Construction. The embankment shall be placed in accordance with Construction Specification for earth fill in Pond (378).

Class III Dikes

The site shall be cleared of trees, brush, other vegetation, and debris. Trees and stumps shall be cut at approximate ground level. The surface of the foundation area shall be scarified before placement of the embankment material.

Dikes constructed from channel spoil may be shaped to approximate cross section. However, the spoil must be of required height and left so that sloughing and sliding will not impair the design section.

When dumped fill is used for dike construction, it shall be placed in layers or deposited in a manner suitable to the equipment used and the material excavated. Shaping shall be done so as to break up lumps and clods of earth. Excessively wet material shall be placed to permit free drainage and shaped after it has drained.

When the fill slumps due to wetness, the dike shall be constructed in stages.

Earth fill around conduits through the dike shall be thoroughly tamped.

Seeding Specifications. An adequate protective cover of grasses shall be established on all exposed surfaces of all classes of dike. Fertilizing and seeding will be applied in accordance with Critical Area Planting (342).